April 25, 2006

Clarification of the U.S. Department of Energy's Perspective on the Status of Mercury Control Technologies for Coal-Fired Power Plants

On April 18, 2006 the Pennsylvania Federation of Sportsmen's Clubs (PFSC) issued a press release through PRNewswire that presented a somewhat inaccurate account of the U.S. Department of Energy's perspective on the current status of mercury control technologies for coal-fired power plants. The press release was based on statements made by Thomas J. Feeley, III, a technology manager at the Department's National Energy Technology Laboratory (DOE/NETL), during an appearance on WPSU-TV's public affairs program -- *Pennsylvania Inside Out* -- that aired April 14th in which Mr. Feeley discussed mercury-related topics with the Secretary of the Pennsylvania Department of Environmental Protection Kathleen McGinty. Given the nature and format of WPSU-TV's *Pennsylvania Inside Out* program, it is understandable that PFSC may have misinterpreted the context of some of Mr. Feeley's statements concerning the commercial availability and cost of mercury controls. The following information is provided to clarify DOE/NETL's perspective on the readiness of technologies for controlling mercury emissions from coal-fired power plants and their associated costs.

DOE/NETL's Mercury Control Technology Research & Development Program

DOE/NETL, in partnership with a number of key stakeholders, has been carrying out a comprehensive research program focused on the development of advanced, cost-effective mercury control technologies since the mid-1990s. Considerable progress has been made during that time in advancing our basic understanding of mercury in coal-fired power plant flue gas and what technologies could be used to control power plant mercury emissions. However, while DOE is very encouraged by the results of our mercury control technology development efforts to date, ***there remain a number of critical technical and cost issues that need to be resolved through additional research before these technologies can be considered commercially available for all U.S. coals and the different coal-fired power plant configurations in operation in the United States***. Several key points related to the status and cost of mercury control technologies are summarized below.

- *Development Status of Mercury-Specific Control Technology*

  Under DOE/NETL's current field testing activity mercury-specific control technologies such as activated carbon injection (ACI) are being tested at a number of coal-fired power plants. These tests have yielded very promising results in most cases. For instance, improved activated carbon sorbents have been developed and are being tested that can capture the more difficult to remove elemental form of mercury. Elemental mercury is the predominant species of mercury formed when burning lower-rank coals (subbituminous and lignite) that have low chlorine content. The progress achieved under DOE/NETL's field testing program has led to several recent announcements of sales of ACI systems to the electric-utility industry.

However, as alluded to above, one size does not fit all in regards to controlling mercury from the broad range of coals burned by, and various pollution control equipment installed on, today's coal-fired power plants. Higher-sulfur bituminous coals are a case in point. During combustion, plants burning medium to high sulfur coal can produce acid gases, such as sulfur trioxide (SO_3), that compete with mercury for bonding sites on the activated carbon. Consequently, the presence of SO_3 in coal combustion flue gas may limit the effectiveness of mercury control via ACI. A recent DOE/NETL field test on a plant burning a high-sulfur Ohio coal has shown ACI to be relatively ineffective in capturing mercury. DOE/NETL has scheduled additional ACI field tests at five bituminous coal-fired units to address this concern.

Another technical performance issue that needs further investigation relative to ACI is the type of particulate control device installed on the power plant. The majority of U.S. power plants are equipped with electrostatic precipitators (ESP) to remove particulate matter (i.e., fly ash) from the flue gas, while some use fabric filters. Activated carbon is injected upstream of the particulate control device to enable simultaneous capture of the mercury and removal of the spent carbon and fly ash. The effect of continuous long-term ACI operation on a power plant's particulate control device is still under investigation. DOE/NETL field testing at a bituminous-fired power plant equipped with an ESP with a relatively small collection area has shown that ACI can have a detrimental effect on ESP performance and lead to carbon breakthrough from the ESP which can effect operations of the downstream sulfur dioxide (SO_2) emissions control equipment. Therefore, further field testing is being carried out to assess this and other technical performance issues.

Finally, DOE/NETL's current mercury control field testing program has been limited to testing at 28 coal-fired units, representing about only 2.3% of the 1,165 coal-fired generating units in operation in the United States.

- *Co-Removal of Mercury in Flue Gas Desulfurization Systems*

Mr. Feeley stated that "*there is existing technology that has already proven to be able to take mercury out [of coal combustion flue gas]*." This statement was made in the context of Pennsylvania's proposed mercury control regulation that is based on the co-removal of mercury in flue gas desulfurization systems (i.e., wet scrubbers) designed to remove SO_2. Wet scrubbers have been employed by the electric utility industry for more than thirty years to meet ever increasingly stringent SO_2 regulations, thus, it is considered an "existing technology."

Recent data collected by DOE/NETL, the U.S. Environmental Protection Agency, and others indicate that wet scrubbers are also effective in capturing the oxidized form of mercury. Oxidized mercury is the form of mercury most commonly found when combusting higher chlorine bituminous coals, such as those mined and burned in Pennsylvania. This mercury is soluble and can be washed out in the scrubber along with the SO_2. It is very important to note that the co-removal of mercury across existing technology such as wet scrubbers will vary significantly based on the chemical forms of mercury present. Recall above that low-rank coals tend to produce more elemental mercury, which is insoluble and can not be removed in the scrubber. Bituminous coals also produce some elemental mercury that will not be captured in the scrubber. And even for the oxidized mercury, the level of removal across wet scrubbers has been shown to range from about 70% to 90%. Further complicating the overall effectiveness of wet scrubbers in removing mercury is the fact that some of the mercury captured by the scrubber may be re-released through a yet-to-be completely understood process in which the oxidized mercury is chemically reduced back to its elemental form. DOE/NETL is carrying out research to better understand and control this phenomenon.

Regarding Mr. Feeley's statements concerning the cost of mercury control via scrubbers, under the proposed Pennsylvania mercury regulation, mercury reductions will result from the installation of wet scrubbers to meet the new Federal Clean Air Interstate Rule that calls for further cuts in SO_2 (and nitrogen oxide) emissions. Therefore, it can be argued that the cost of mercury reduction is "free," that is, it is a co-benefit of the cost of installing and operating the scrubber for controlling SO_2. However, there could be relatively significant future costs associated with the impact of mercury control on the management of the solid byproducts produced by the scrubber that is discussed below.

- *Cost of Activated Carbon Injection*

While mercury control via ACI is "relatively inexpensive" on a capital-cost basis, the cost reported by Mr. Feeley of $5 - $7 per kilowatt was presented to contrast with the relatively high capital cost of SO_2 scrubbers. That is, a utility would not choose to install a high-capital cost wet scrubber for the sole purpose of capturing mercury, but would likely choose a less expensive technology like ACI. Moreover, it is important to note that capital costs are only one part of the overall levelized cost of controlling mercury. A preliminary DOE/NETL economic analysis has revealed that the annual operating and maintenance (O&M) costs associated with ACI represent over 80% of the total levelized cost. Annual O&M costs consist of several components, including: (1) activated carbon consumption; (2) activated carbon disposal; (3) other costs (electric power, O&M labor, and spare parts); and (4) the cost of the management and disposal of the power plant's coal combustion byproducts (which we will discuss in more detail below). Primarily, the annual O&M costs are dominated by activated carbon consumption costs since the ACI mercury control technology involves the continuous injection of activated carbon into the flue gas.

The ACI capital cost of \$5 - \$7 per kilowatt stated by Mr. Feeley also represents a situation where the only new equipment being installed is the activated carbon storage silo and injection system. However, there will be cases where a new fabric filter is added in order to separate the collection of the activated carbon from the collection of the bulk of the plant's fly ash. Such an ACI configuration, known as TOXECON™ is currently being tested under DOE's Clean Coal Power Initiative at WeEnergies' 270 megawatt (MW) Presque Isle Power Plant located in Marquette, Michigan. For this application, the total capital cost for the ACI system, including the new fabric filter, is approximately \$126 per kilowatt.

- *Impacts of Mercury Control on Cost of Electricity*

Mr. Feeley's statement that DOE/NETL's preliminary economic analysis of ACI indicate that impacts on electric utility rates are not expected to be significant is correct, but must be considered in the context that it represented the "best case" economic scenario. The severity of the potential impact on the cost of electricity (COE) depends on several factors, including: (1) the rate in which the activated carbon is injected to comply with a given mercury control regulation; (2) the type of ACI system selected; (3) equipment retrofit difficulties; and (4) the impact of ACI on current coal combustion byproduct management and disposal practices. While preliminary ACI cost estimates are encouraging, they generally assume an uncomplicated retrofit and minimal economic impact due to the installation of the ACI system. The encouraging economics reported by Mr. Feeley are also based on the assumption that mercury control via ACI will not cause any balance-of-plant impacts such as particulate control equipment performance, but more significantly, changes in the disposal and marketing (sale) of coal byproducts. Based on DOE/NETL's economic analysis, potential future regulatory implications as to how coal byproducts are managed due to concerns about mercury could increase the COE associated with mercury control by a factor of two-to-four compared to the mercury control COE without byproduct impacts. This is discussed in more detail below.

- *Potential Impacts of Mercury on Coal Byproducts Management and Associated Costs*

One topic not discussed during *Pennsylvania Inside Out* is the potential negative impacts of mercury control on the sale and disposal of coal combustion byproducts such as fly ash and the solids generated by SO_2 scrubbers, which in turn could dramatically increase the cost of mercury control. Currently, coal byproducts are regulated as non-hazardous and many power plants sell their fly ash and scrubber solids for use in cement and concrete, or in making wallboard. Because mercury control, whether by ACI or via SO_2 scrubbers, will result in increases, albeit small, in the concentration of mercury in coal byproducts, there is the possibility that these materials may be regulated in a manner that would lead to higher disposal costs and loss of current beneficial-use markets. This is driven by concerns that the mercury in the coal byproducts could be released to the environment. Because of the concern about the impact of mercury on coal combustion byproducts, DOE/NETL's preliminary estimate of the cost of ACI discussed above looked at two scenarios – one without any byproduct impacts and one with byproduct impacts. ***The byproduct impact scenario as much as tripled the cost of mercury control on a dollar per pound of mercury removed basis and increased COE by a factor of as much as four for some coal-fired generating units.*** In response, DOE/NETL is carrying out research directed at evaluating the fate of mercury in coal combustion byproducts and developing ways to ensure that the mercury is not released.

Additional information on DOE/NETL's mercury control technology R&D program can be found at: http://www.netl.doe.gov/technologies/coalpower/ewr/mercury/index.html